MET Block & Variables

- Importance of Missing E_T at DØ
- Changes to missingET package
- Root-tuple blocks from met_analyze
- Missing transverse energy variables
- Visible and scalar energy variables
- MET example plots
- Conclusion

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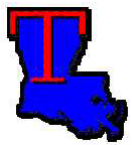


Importance of Missing E_T at DØ

- Combines: Central Tracking, Calorimeter & Muon
  - $\not\!\!E_T$ calculated from Cal cell energies & muon momentum
  - ICD: Reduces rate of fake $\not\!\!E_T$
    - Due to energy resolution fluctuations or incompletely instrumented regions of the detector
  - Calorimeter commissioning
    - Asymmetry in the missing transverse energy phi distribution for single electron events
- Inference of undetected particles e.g. neutrinos
  - Broad range of physics topics
    - EW, Top, Higgs, SUSY
      - Search for mSUGRA signature: 1 e, 4+ jets & large $\not\!\!E_T$
      - WZ production: tri-lepton + $\not\!\!E_T$
      - Top mass measurement in di-lepton channel: two charged leptons, two neutrinos and two jets

Changes to missingET package

- New algorithms to calculate new variables
- Removed specialized constructor used only by PMCS
  - Use default constructor with set methods for some variables
- Removed boolean absET2
  - Did nothing & original purpose was not clear
- Added rcps for:
  - cellThreshold (>100 MeV)
  - towerThreshold (>200 MeV)
  - etaLimit (η<33)
- Initialize function:
  - void setAllZero (void);
- All variables placed in thumbnail by default
  - Do we want this?
  - Increased packing (S.B.)
- Full compliment of *set/get/print* methods for all variables
  - old methods were left unchanged

Algorithm Details

$$E_{x,y}^{Vis.CAL} = \sum_{cells} E_i^{x,y}$$

$$ME_{x,y}^{CAL} = -E_{x,y}^{Vis.CAL}$$

$$MET^{CAL} = \sqrt{(ME_x^{CAL})^2 + (ME_y^{CAL})^2}$$

$$SET^{CAL} = \sum_{cells} \sqrt{(E_i^x)^2 + (E_i^y)^2}$$

$$ME_{x,y}^{CAL+MUON} = ME_{x,y}^{CAL} - P_{x,y}^{MUON,vis}$$

$$P_{x,y}^{Muon,vis} = \sum_{muons} p_i^{x,y}$$

$$MET^{CAL+MUON} = \sqrt{(ME_x^{C+M})^2 + (ME_y^{C+M})^2}$$

met_analyze package

MET

Missing Transverse Energy: *ScalarET, METx, METy, MET*

- Calorimeter + ICD ➔ cells or towers
- Calorimeter + ICD with muon correction ➔ cells or towers
  - *(tight muons in muonid)*

Visible Energy: *SET, VETx, VETy, VET*

- Calorimeter + ICD ➔ cells or towers
  - Above/Below ieta limit (32 inclusive)
  - Signal/Noise (E_cells>100 MeV, E_towers>200 MeV)
  - ICD cells only; NADA killed cells
- Muon: *Px, Py, Pz, Pt*

METMET

Old variables (jetanalyze METOLD block)

MET, MEx, MEy, SET, MEphi
METNE, MExNE, MEyNE, SETNE, MENEphi
METWE, MExWE, MEyWE, SETWE, MEWEphi
SMuX, SMuY, SMuZ, Zvtx

METRING

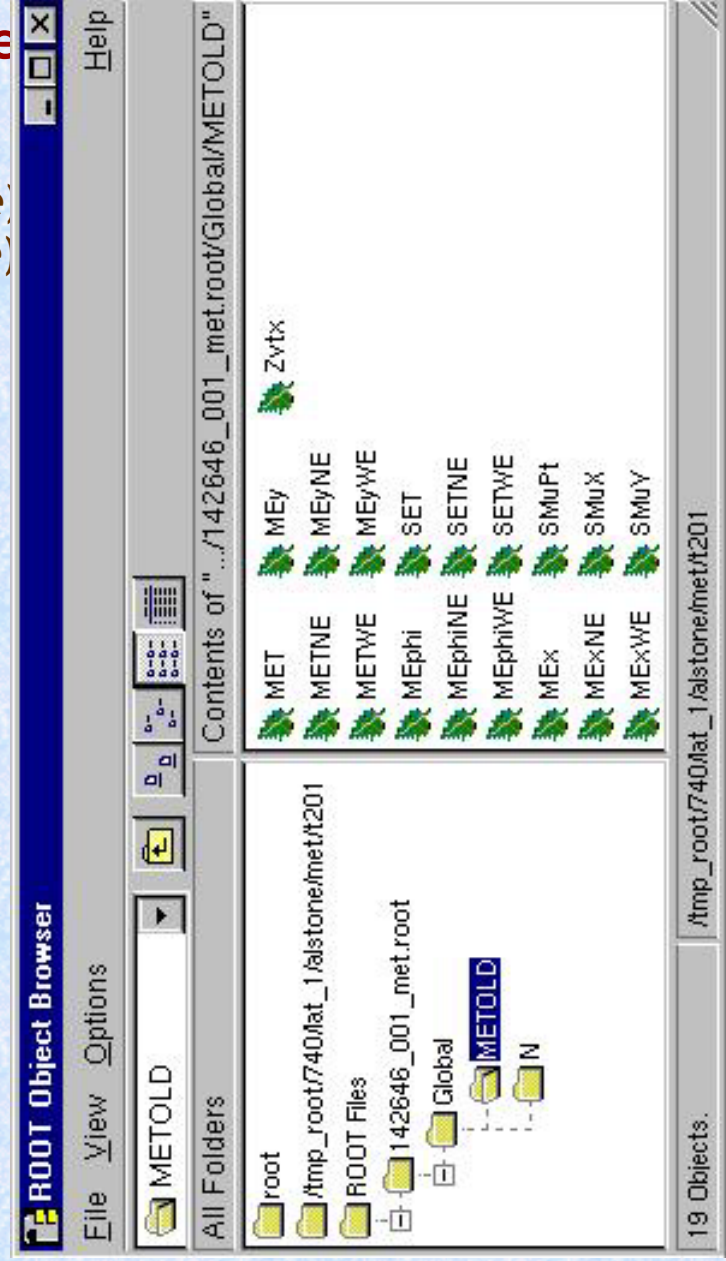
Ring variables for revertexing (EM & Had. components, 42 ieta segments)

Nrings
RingEMx[42], RingEMy[42]
RingHDx[42], RingHDy[42]

METOLD block in **jetanalyze** (METMET in **met_analyze**)

➔Calculated from towers in CalData chunk

MET	Missing Et Calorimeter only
METx	x component of MET - Cal only (can be negative)
METy	y component of MET - Cal only (can be negative)
MEphi	METx/METy
SET	Scalar ET
METNE	Same as MET with threshold of 200 MeV/tower
METNEx	Same as METx w/threshold of 200 MeV/tower
METNEy	Same as METy w/threshold of 200 MeV/tower
MEphiNE	METNEx/METNEy
SETNE	Same as SET w/threshold of 200 MeV/tower
METWE	Same as METNE with $\|i\eta\|<33$
METWEx	Same as METNEx with $\|i\eta\|<33$
METWEy	Same as METNEy with $\|i\eta\|<33$
MEphiWE	METWEx/METWEy
SETWE	Same as SETNE with $\|i\eta\|<33$
Zvtx	primary reconstructed Z position of vertex
SMuX	px sum of the "good muons"
SMuY	py sum of the "good muons"
SMuPt	Transverse momentum of the "good muons"



Upgrade to MET Block

SET: scalar ET obtained as the sum of cell energy*abs(sin(theta)). A cell with negative energy will give a NEGATIVE contribution to SET.
VETx: x of vect. ET obtained as the sum of the cell energy*sin(th)*cos(ph)
VETy: y of vect. ET obtained as the sum of the cell energy*sin(th)*sin(ph)
VETz: z of vect. ET obtained as the sum of the cell energy*cos(th)
(in these 3 variables the energy can be positive or negative)

VET=sqrt(VETx**2+VETy**2)

The x and y component of the Missing ET (METx, METy) are simply:

METx=-VETx
METy=-VETy

The missing transverse energy is obtained by

MET=sqrt(METx**2+METy**2) , and of course MET=VET.

In the detailed variables, we use VETx, VETy, VETz in order to have a symmetric (same sign) treatment of calorimeter and muons, e.g.

VETx=+VETCALOx+VETMUONx, etc...

Structure of the current MET block

Global variables:

SETT	Scalar Et constructed from Cal-ICD Towers	(=+SETTAS +SETTBS)
METTx	x component constructed from Cal-ICD Towers	(=-VETTASx-VETTBSx)
METTy	y component constructed from Cal-ICD Towers	(=-VETTASy-VETTBSy)
METT	Missing Et constructed from Cal-ICD Towers	
METTM	Scalar Et constructed from Cal-ICD Towers&Muon	(+SETT +SETMUON)
METTMx	x component constructed from Cal-ICD Towers&Muon	(-VETTx-VETMUONx)
METTMy	y component constructed from Cal-ICD Towers&Muon	(-VETTy-VETMUONy)
METTM	Missing Et constructed from Cal-ICD Towers&Muon	
SETC	Scalar Et constructed from Cal-ICD Cells	(+SETCAS +SETCBS)
METCx	x component constructed from Cal-ICD Cells	(-VETCASx-VETCBSx)
METCy	y component constructed from Cal-ICD Cells	(-VETCASy-VETCBSy)
METC	Missing Et constructed from Cal-ICD Cells	
SETCM	Scalar Et constructed from Cal-ICD Cells&Muon	(+SETC +SETMUON)
METCMx	x component constructed from Cal-ICD Cells&Muon	(-VETCx-VETMUONx)
METCMy	y component constructed from Cal-ICD Cells&Muon	(-VETCy-VETMUONy)
METCM	Missing Et constructed from Cal-ICD Cells&Muon	

SETTAS Scalar sum of Towers Above eta limit, E_tow > twr-thresh.
VETTASx Vectorial sum of Towers Above eta limit, E_tow > twr-thresh.

SETTBS Scalar sum of Towers Below eta limit, E_tow > twr-thresh.
VETTBSx Vectorial sum of Towers Below eta limit, E_tow > twr-thresh.

SETTAN Scalar sum of Towers Above eta limit, E_tow < twr-thresh.
VETTANx Vectorial sum of Towers Above eta limit, E_tow < twr-thresh.

SETTBN Scalar sum of Towers Below eta limit, E_tow < twr-thresh.
VETTBNx Vectorial sum of Towers Below eta limit, E_tow < twr-thresh.

TOWERS

SETCAS Scalar sum of Cells Above eta limit, E_cell > cel-thresh.
VETCASx Vectorial sum of Cells Above eta limit, E_cell > cel-thresh.

SETCBS Scalar sum of Cells Below eta limit, E_cell > cel-thresh.
VETCBSx Vectorial sum of Cells Below eta limit, E_cell > cel-thresh.

SETCAN Scalar sum of Cells Above eta limit, E_cell < cel-thresh.
VETCANx Vectorial sum of Cells Above eta limit, E_cell < cel-thresh.

SETCBN Scalar sum of Cells Below eta limit, E_cell < cel-thresh.
VETCBNx Vectorial sum of Cells Below eta limit, E_cell < cel-thresh.

CELLS

SETICD Scalar sum of ICD cells only
VETICDx Vectorial sum of ICD cells only

SETNADAx Scalar sum of NADA cells
VETNADAx Vectorial sum of NADA cells

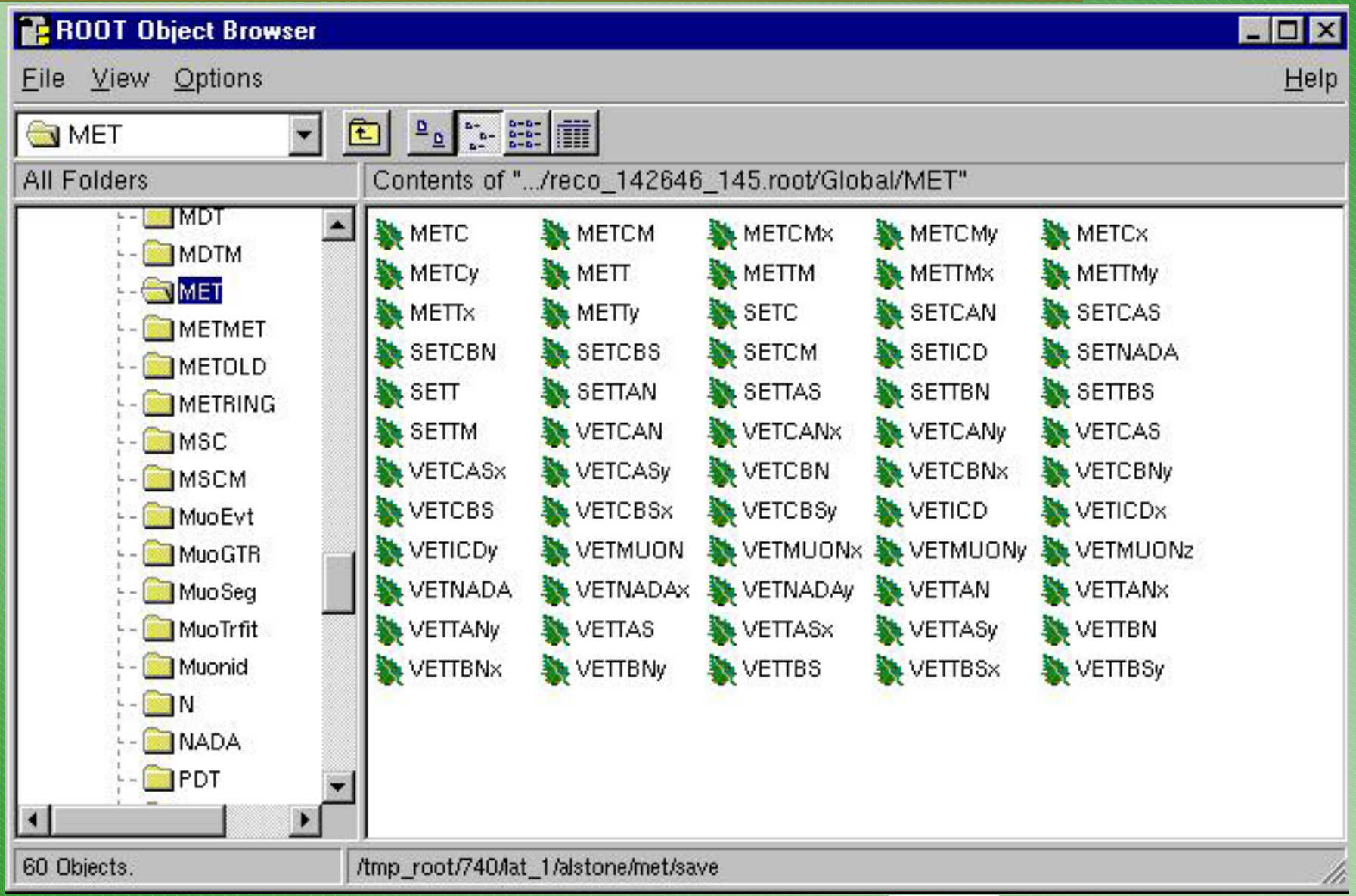
SETMUONx Scalar sum of MUONs
VETMUONx Vectorial sum of MUONs

The MUON, ICD, NADA quantities are given for systematic studies. They are not used explicitly in the global MET/SET calculations done in this block, since the ICD is already included in the Tower and Cells variables, and since NADA hot cells have already been suppressed. However, if NADA is ran in shadow mode then the NADA quantities can be used to obtain a NADA corrected missing/Scalar ET. Conversely, if NADA has been run in killing mode, the non-NADA corrected MET can be trivially restored using the detailed NADA variables.

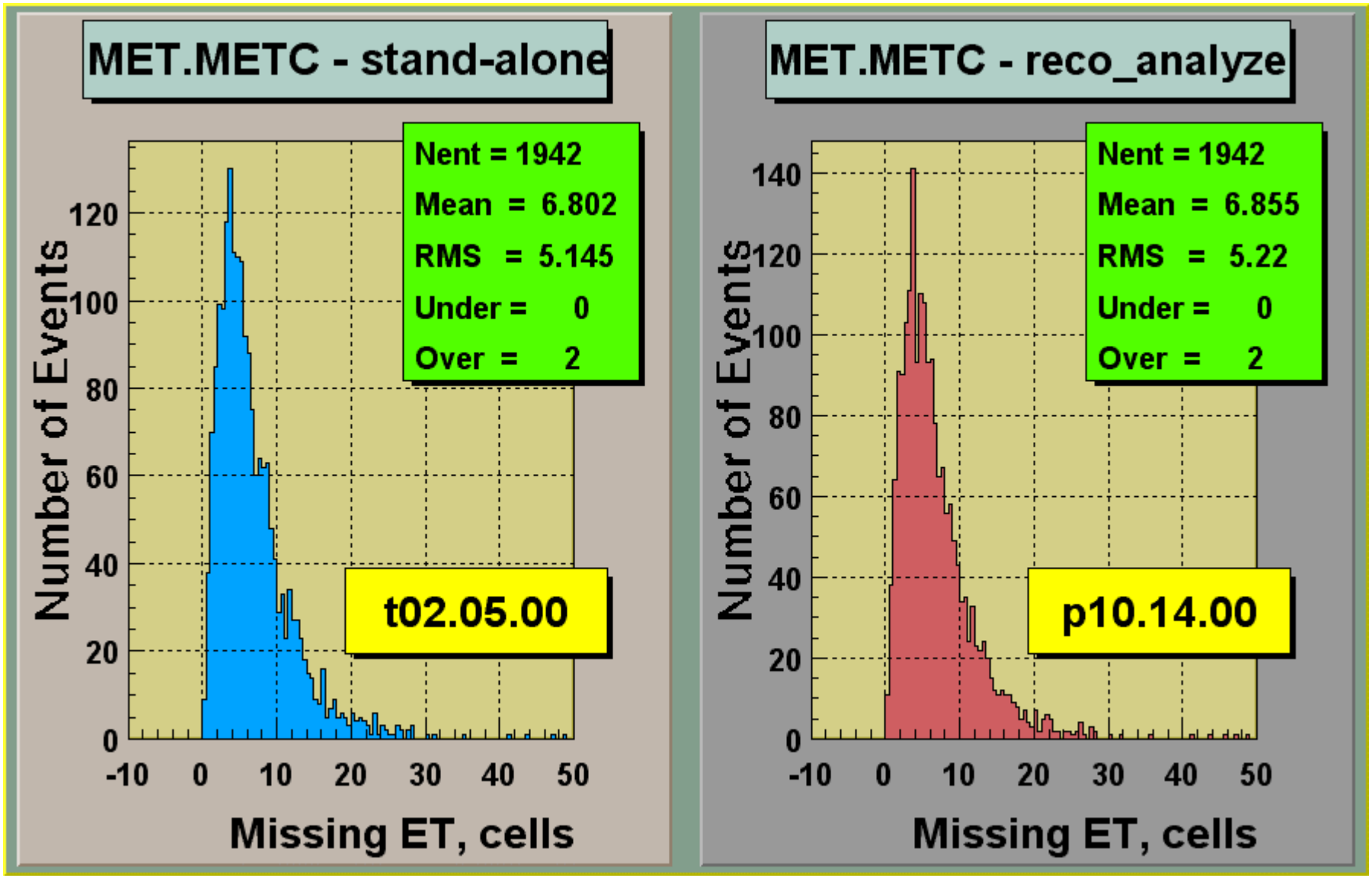
The revertexing block corresponds to the VETTAS+VETTBS quantities.
(i.e. the total vectorial E_T obtained from towers above tower threshold).

The WE/NE concept of the old MET block is implemented in this scheme
by the 2 complementary quantities:
SETTAS (towers above eta limits) and SETTBS (towers below eta limit),
i.e. SETT=SETTAS+SETTBS (similary for VETxy, MET).

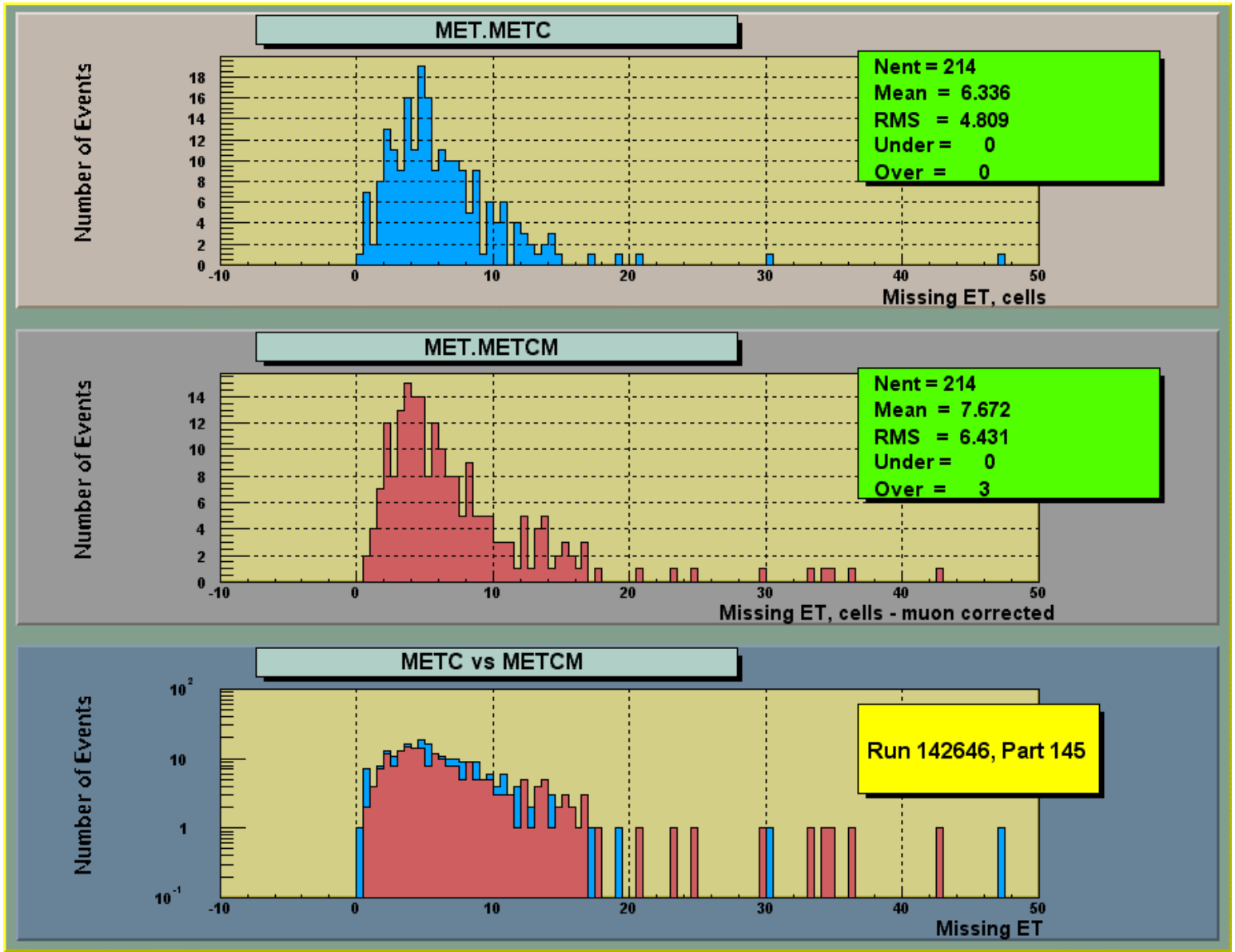
New MET Root-tuple Block



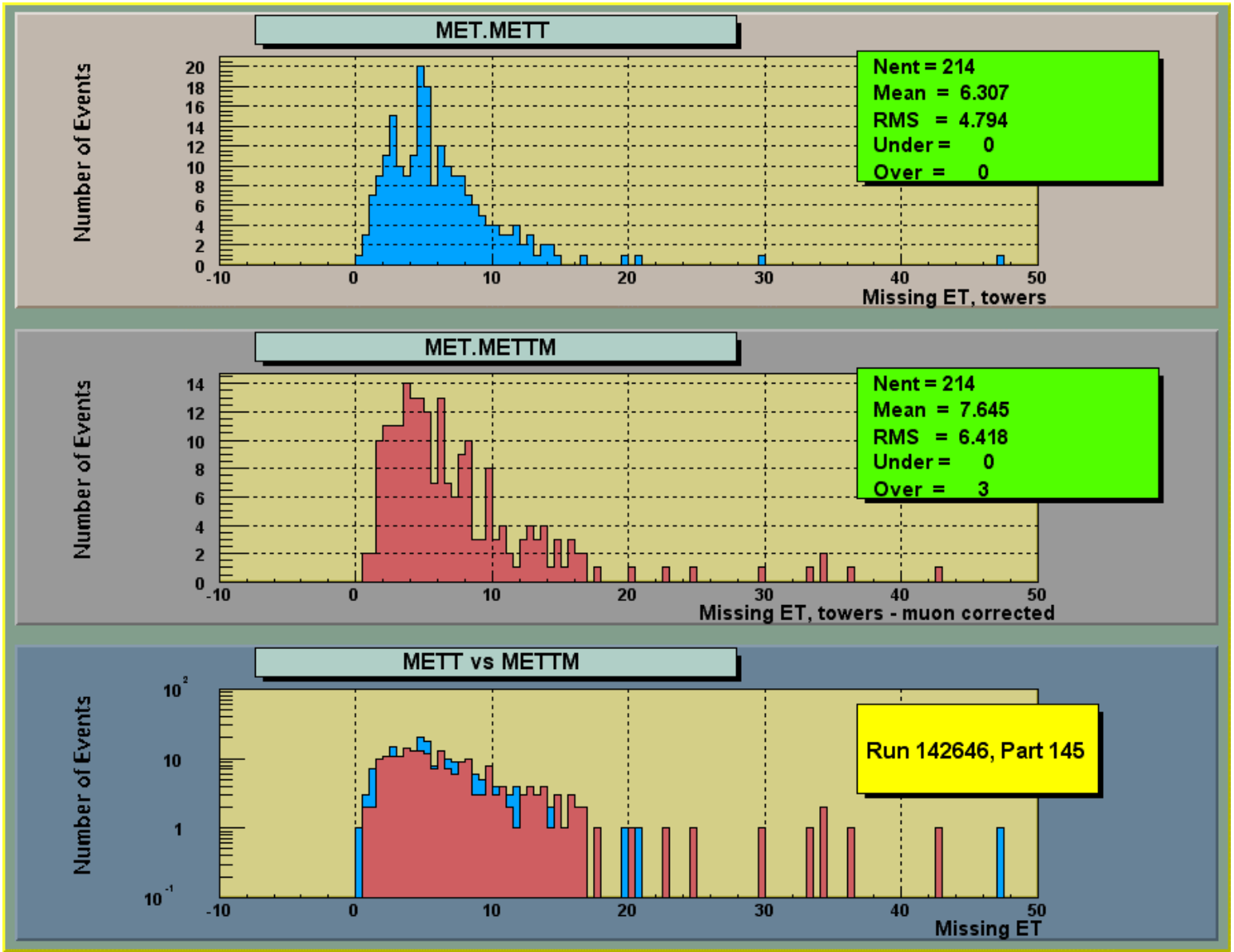
Missing ET, cells - reco_analyze



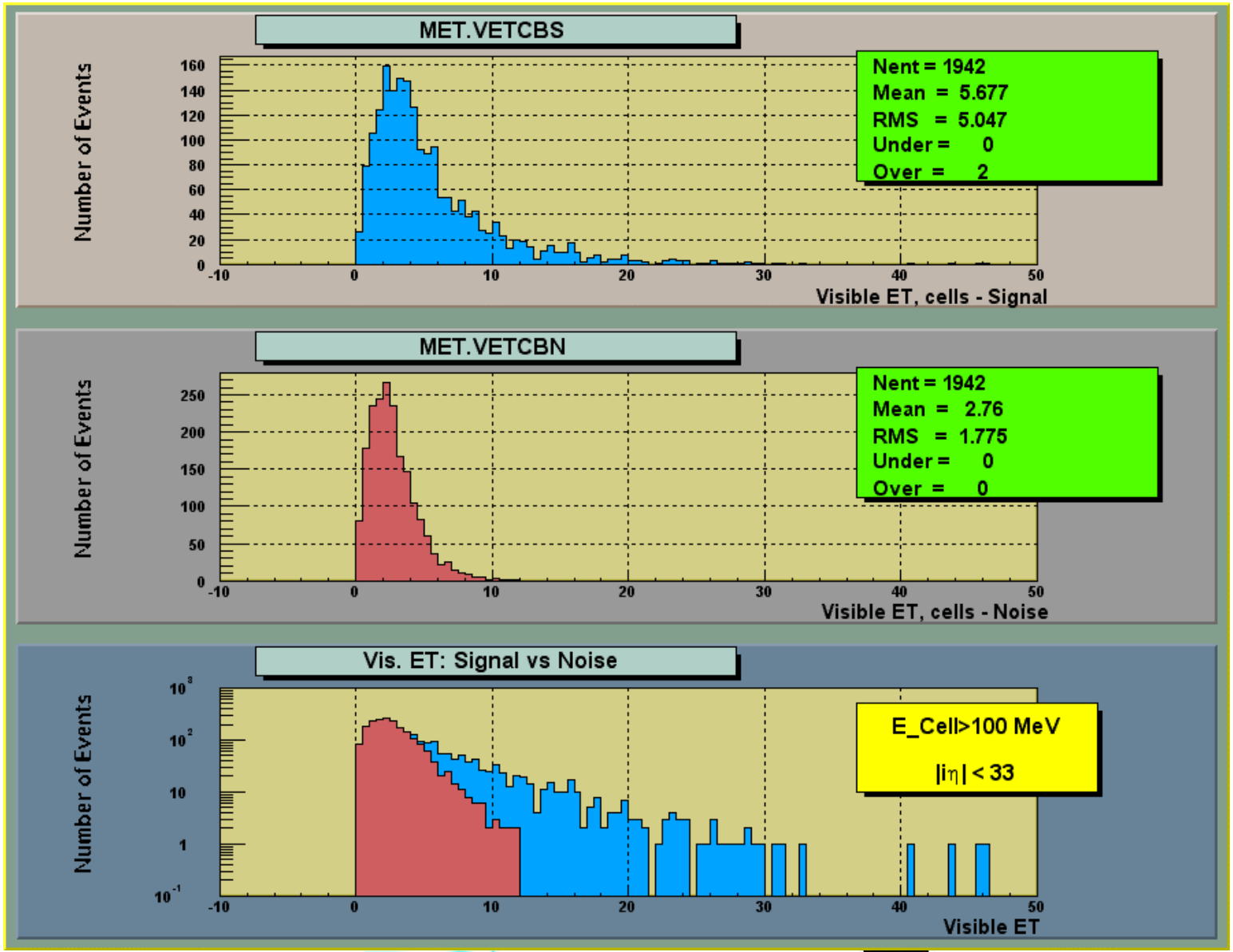
Missing ET, cells - Muon corrected



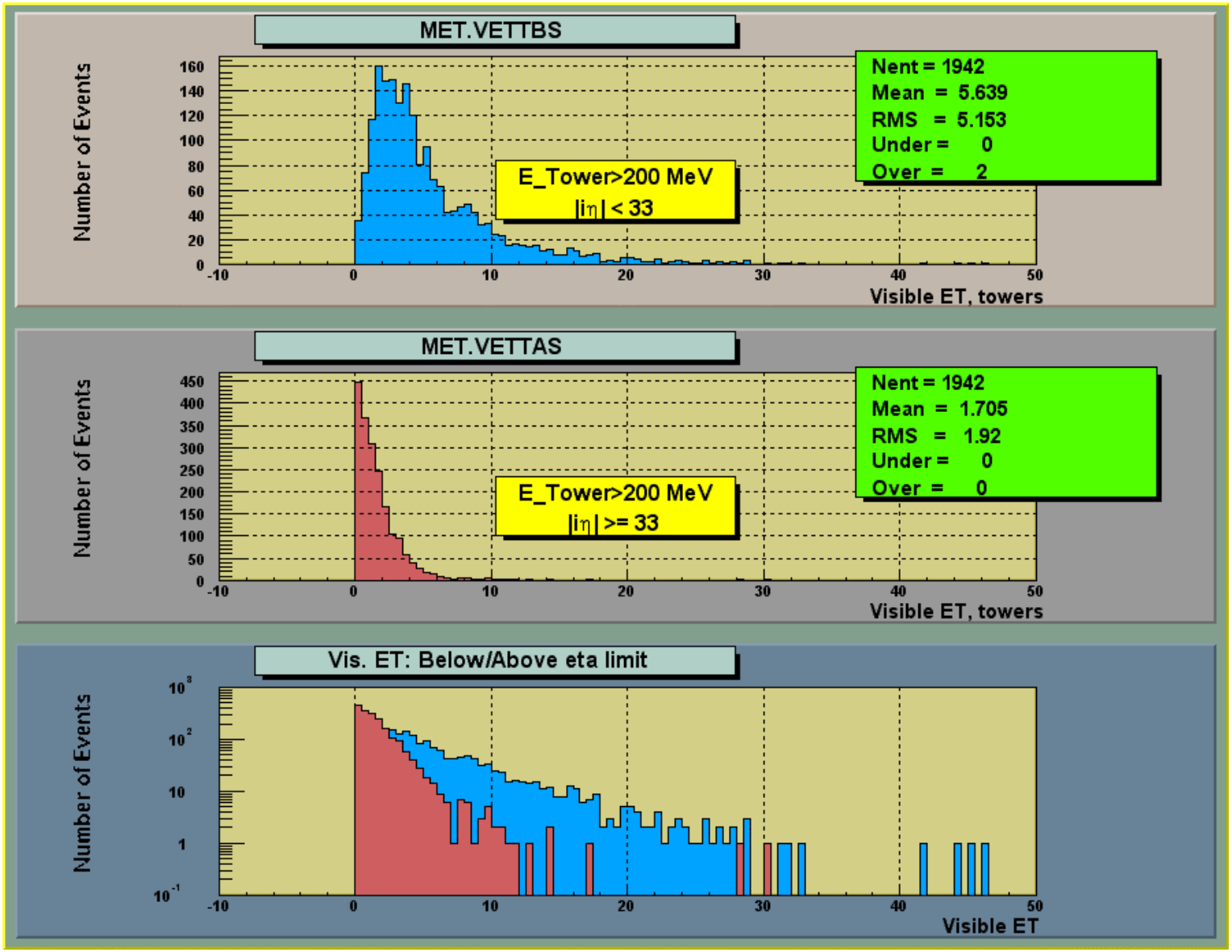
Missing ET, towers - Muon corrected



Visible ET, cells: Signal vs Noise



Visible ET, towers: Below/Above eta limit



Conclusion

- Thoroughly tested new code in D0 environment
  - met_analyze was released upon the collaboration two months ago
  - missingET with all new variables was completed one month ago
    - Meaningful and rigid name structure!
  - Requested that both packages be part of the next production
- Increased block from 19 to 60 variables!
  - Standardization! People were using private code
    - Multiple versions trying to do the same thing
    - Did not fully understand the workings of the calorimeter
  - Muon Correction!
    - Necessary for physics analyses (Electroweak, NP, etc.)
  - Expert studies
    - Signal vs Noise; with or w/o ICD; Central or Forward Calorimeter
- Root-tuples ➔ Thumbnails
- Waiting for feedback from users …
  - Bugs? Request for new variables. RCP default changes. Etc.